BANANA FIBER: A NEW WORLD OF SUSTAINABLE FIBER AND THEIR PRODUCT

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ABSTRACT: Natural fibers have been used as an alternative to synthetic ones for their greener character; banana fibers have the advantage of coming from an agricultural residue. fibers have been extracted by mechanical means from banana tree pseudostems, as a strategy to valorize banana crops residues. to increase the mechanical properties of the composite, technical textiles can be used as reinforcement, instead of short fibers. to do so, fibers must be spun and woven. the aim of this paper is to show the viability of using banana fibers to obtain a yarn suitable to be woven, after an enzymatic treatment, which is more environmentally friendly. extracted long fibers are cut to 50 mm length and then immersed into an enzymatic bath for their refining. conditions of enzymatic treatment have been optimized to produce a textile grade of banana fibers, which have then been characterized. the optimum treating conditions were found with the use of biopectinase k (100% related to fiber weight) at 45c ˝ ph 4.5 for 6 h, with bath renewal after three hours. the first spinning trials show that these fibers are suitable to be used for the production of yarns. the next step is the weaving process to obtain a technical fabric for composites production.

keywords: banana fibers; enzymatic treatment; yarn; composites; reinforcement; sustainability

INTRODUCTION:

Natural fibers have been used historically to produce our clothes, carpets, cordage, paper, ships sails, and insulation and building materials. The use of natural fibers, both plant, and animal, to meet our needs goes back thousands of years and plays a significant role in history. As the fashion industry heads towards a future where textile resources are scarce, natural fibres such as cotton, which remains a resource-intensive material, and petroleum-based fibres like acrylic, polyester, nylon and spandex remain high in demand. But as the production of these fibres continues to do irreversible damage to the planet, more and more companies are seeking out sustainable alternative fibres and fabrics. In this new series, FashionUnited explores thesustainable alternatives and textile innovations that are currently being pursued all over the world. In this instalment, Fashion United explores the potential use of banana fibre.

In the present era, fibre yielding plans may be regarded as the important crop after cereals. In fact, plant fibers are the raw material for many vita industries sustaining the economy of our times. Over a long period of trial and use, the advantage of some fibrehas been recognised while others have been rejected due to variety of reasons. This selection based on long experience, has resulted in only a few out of many fibres occurring in nature. Some of them are rally very important, while others find some limited application.

India being a tropical country is very rich in vegetable or natural fibers.the vegetable fibersmostly of long and staplewith considerable stiffness. Vegetable fibers may be classified into five classes according to plants part from which they are obtained. A. seed fiber b. bastfiber c.leaffibers. D. wood fiber e. miscellaneous fiber. Apart from all these a variety of fibers are obtained from various parts of plants, e.g.sheating leaf stalk of palm tree, coir fibr, stem fiber like banana fiber etc., which are grouped under miscellaneous fibers of plant origin.

Banana fibre, also known as *musa fibre* is one of the world's strongest natural fibres. Biodegradable, the natural fibre is made from the stem of the banana tree and is incredibly durable. The fibre consists of thick-walled cell tissue, bonded together by natural gums and is mainly composed of cellulose, hemicelluloses and lignin. Banana fibre is similar to natural bamboo fibre, but its spin ability, fineness and tensile strength are said to be better. Banana fibre can be used to make a number of different textiles with different weights and thicknesses, based on what part of the banana stem the fibre was extracted from. The thicker, sturdier fibres are taken from the banana trees outer sheaths, whereas the inner sheaths result in softer fibres. Banana fibre is a more sustainable alternative to silkAlthough not many people are aware of its existence or use, banana fibre is not a recent innovation. People have been making fibres out of banana stems since the early 13th century, in Japan. But using banana trees as a source of fibre to make textiles declined as other fibres such as cotton and silk from China and India became increasingly popular. But now banana fibre is making a comeback in the fashion industry. Recently banana fibre has been making a comeback in numerous industries and is used all over the world for multiple products, ranging from tea bags to car tyres to saris and Japanese yen notes.
Banana fiber is obtained from the superimposed leaves forming the pseudostem of the plant, which currently has no use, apart from a low percentage dedicated to cattle feed. It belongs to Musa genre, as a monocot. Banana is the most important crop in Canary Islands, which are the most important producers of bananas in Europe. It is important to highlight that fibers are obtained from the pseudostems of the plant once the fruit has been harvested, and that each plant only bears fruit once; this is one of the

main benefits of banana fibers in comparison with other natural fibers, as this one is obtained from an agricultural residue. Fabrics made from banana fibres are soft and supple, as well as breathable and a natural sorbent. They tend to have a natural shine to them as well and are often compared to silk. In addition, banana fibre is now seen as a sustainable alternative to cotton and silk. Banana fibre, which is said to be nearly carbon neutral, is also often compared to hemp and bamboo, although it is not as durable as the former fibres. At the moment, however, there are certain limitations to what can be made from banana fibres.as an eco friendly substitute in textile industry in place of the environmentally hazardous synthetic fibers. To provide livehood to the rural poor through generation of employment in the fiber producing and processing industry. being completely biodegradable and naturally occurring the banana fiber products are expected to be in great demand in international market as they pose no toxic effects to man and environment. to make value added products which would enhance th profitability of banana forming. to minimize deforestation due to various wood/ cellulose processing industries thus protection our ecology and environment.The characteristics and uses of banana fibre are as follows:

- **Banana fibre** allows you to breathe well, is naturally solvent, and keeps the body cool even on hot days.
- The fabric is soft and supple. It may not be as smooth as rayon or cotton, but it has a natural shimmer. It makes the material look like silk.
- Banana fibre in clothing feels comfortable and does not trigger any allergies.
- It is also fire resistant, heat resistant, water-resistant, and greaseproof.
- It is reasonably strong and durable, as the fabric uses tough outer material.
- Banana fibre is better than any other organic fibre in tensile strength and spin ability.
- **Banana fibre** has an impact on the environment. The production of banana fabric falls in a category among natural fibres with its extreme sustainable property. The material uses fibres from the parts that go waste as only the fruit is used. Turning them into clothing reduces the waste and the demand for processing chemical-induced synthetic fibres.
- With the rise in popularity of banana fibre in the textile industry, finding safe, sustainable, and organically manufactured banana fibre can be a challenge. It is where fashion comes in. We are a leading apparel manufacturing platform that connects fashion brands to experienced manufacturers to keep the fashion supply chain production moving, no matter where you are. We cover everything from ordering, tracking, communication, and payments and even provide you with daily updates about the production so that your process can be more transparent, genuine, and hassle-free.
- **Accessories**: You will find that banana fibre is used more frequently in making accessories. Gloves, hands, and scarfs made from banana fibre have gained popularity.
- **Decor**: In earlier times, the lack of technological development limited the use of banana fibre for rough applications like ropes, doormats, or wall leaves. The enhanced use of this fibre is still a staple in tropical-themed decor items.
- **Automotive Industry**: The second-generation Mercedes-Benz A-class was introduced with a spare tyre covered in polypropylene, compost material, and thermoplastic embedded with banana fibres. This mixture had high road resistance and tensile strength making it withstand strikes or environmental exposure like water, UVB/UV rays, and a few chemicals.
- **Sanitary Napkins**: The International Institute of Environment and Development launched a programme to educate women in Africa (Rwanda) to make environment-friendly and low-cost sanitary napkins using banana fibres.
- In view of large-scale unemployment in the rural sector and the need for developing backward and tribal areas this study was conducted so that village industries concerned with processing of natural fibres an generate enough employment. The present investigation was carried out to collect the information regarding the source of banana fier in jalgaodistric Maharashtra its use.

Material methods:

The following are a few steps involved in the process of making banana fabric:

- **Step 1: Separation:**
  First, the fibres from the banana stems and peels are separated from their non-usable components. Various techniques are used to attain these fibres, which involve soaking the peels in a chemical substance or water to soften and separate the fibres.

- **Step 2: Drying and Bleaching:**
  Once the fibres are separated, they are bunched together and left to dry. After this step, the outer and inner fibres are kept together, as it is hard to separate them when they are wet.
- **Step 3: Grouping:**
  Once the fibres are dry, it is separated into various groups based on quality. Group A contains the best fabrics and is used for silk applications. Some manufacturers only have two groups, whereas others produce different grades of banana fibre.

  Step 4: Softening treatment of Raw fibre: Raw fibrehas more lignin content so remove the harshness and fuzziness of fibre used enzymatic application to soften the fibre surface.To improve the adhesion of natural fibres with the matrix material, the surface is usually modified using alkali. Surface modifications can also be done through eco-friendly enzymatic treatments.

Step 4: Spinning and Weaving: Finally, the separated fibres are spun into yarn. It is dyed, treated and then woven into accessories, c decor items, or industrial products. This process was earlier handmade, making it harder to process on a larger scale. It is where machines come in.

Extraction of banana fibre:
Banana fibre is eco-friendly fibre like jute fibre. The complete process involves mechanical as well as automated mechanical extraction techniques- Initially the banana plant sections were cut from the main stem of the plant and then rolled lightly to remove the excess moisture and impurities. A machine consisting of two horizontal beams is used for extraction process to avoid fibre breaking.

Fibre-Banana fibre will be used for the study. Fibre will be collected from area of Jalgaon Maharashtra at the rate of 250rs/ kg.

Enzymes
The enzymes used for the study and will be collected from Aumgene Biosciences Pvt.Ltd Surat Gujrat.

Desizing of Banana fibres:

Biopectinase Enzyme	0.5, 1, 5, 10, 15, % OWF
pH	4.5
MLR	1:40
TIME	6-7 HOUR with intermediate stirring
Drying at RT	(Oven Drying / Drying at room temperature) Note:Drying at more temp. (above RT) increases stiffness of fibres.
Machine	Winch (model used)

Hot wash 1or 2 times at (70 to 80 c)
Cold wash 1 times.
Spin in machine for water spin. Spread under room temperature or blower.

Findings
Scanning Electron Microscopy (SEM) of fibre Surface:
The scanning electron microscopy (SEM) is a type of electron microscope capable of producing high resolution images of a sample surface. SEM images have a characteristics three-dimensional appearance and are useful for judging the surface structure of the sample.

In the SEM image of untreated banana fibre, it was observed that the fibre surface was covered with overlapping scales, like scales of fish and fibres have much more irregular surface, having more striations on the surface and appeared dull. Desize fibre strand showed slight swelling, striations were decreased but surface was not very clear. Fig: reveals that after acid enzymatic treatment, there was a remarkable change in fibre diameter due to the significant swelling. Also, the surface became more clear, smooth and cylindrical.

LONGITUDINAL VIEW

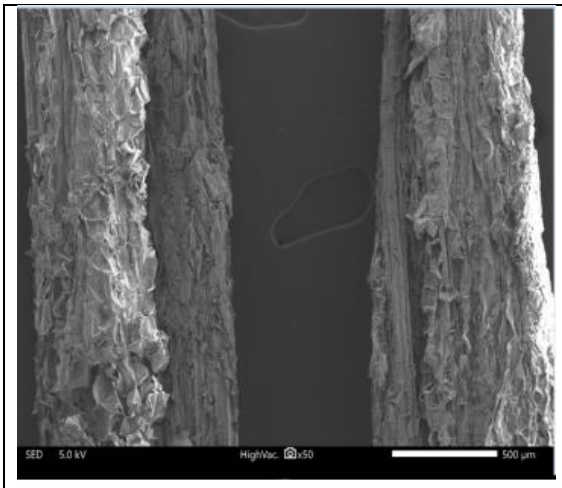


FIG 1: Untreated

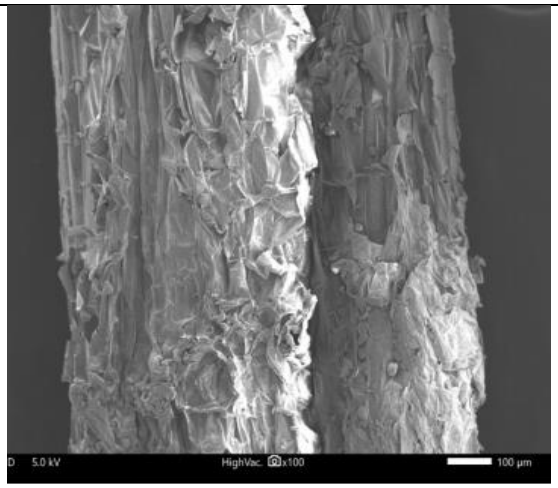


FIG 2: Untreated

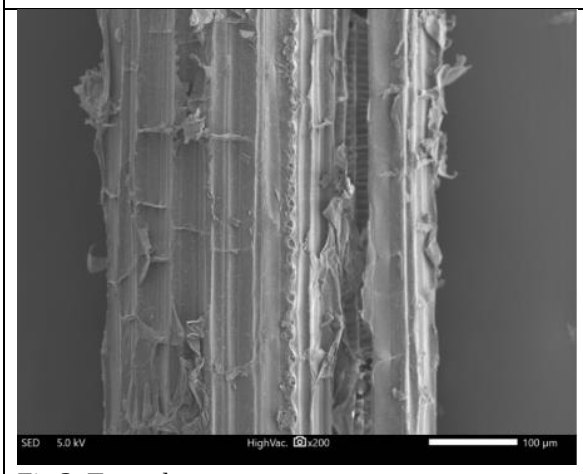


Fig 3: Treated

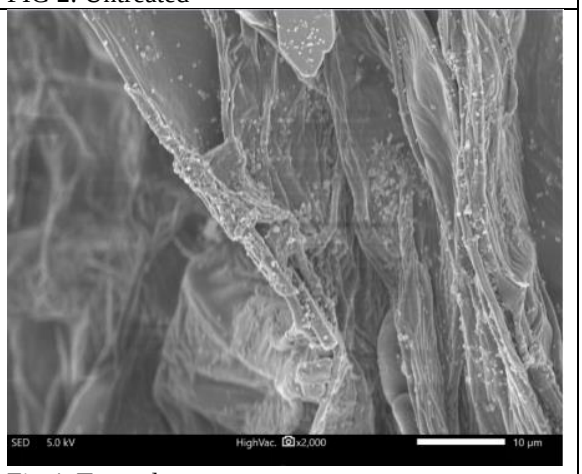


Fig 4: Treated

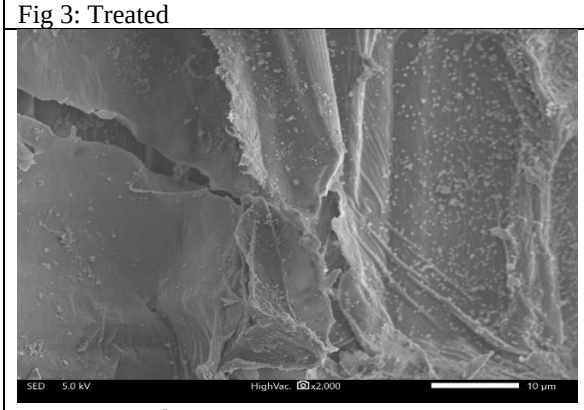


Fig 5: Treated

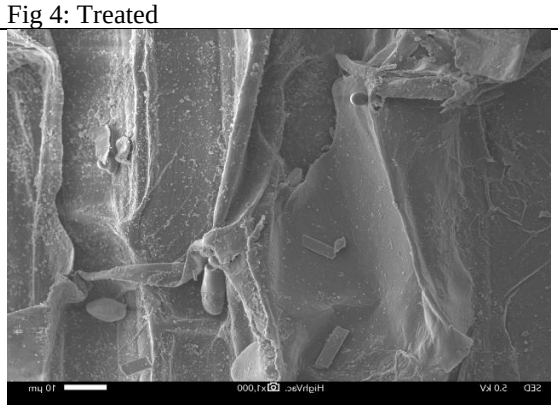


Fig 6: Treated

CROSS SECTIONAL VIEW:

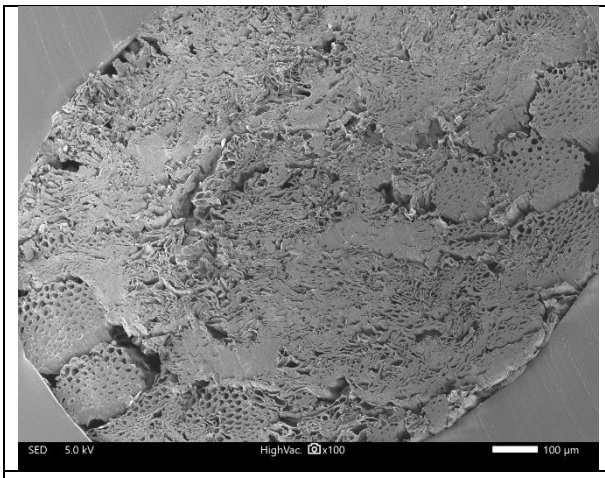


Fig 1: Unterated

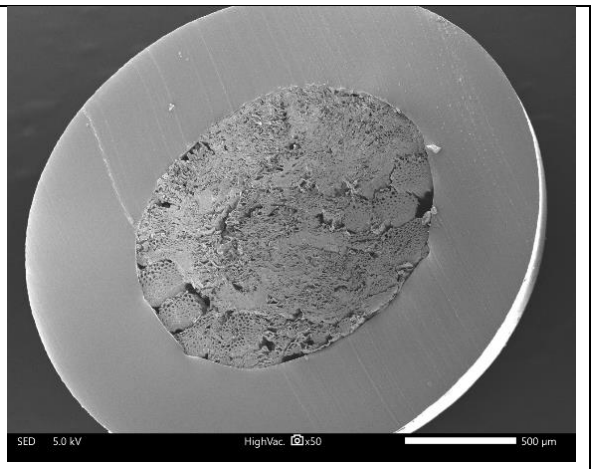


Fig 2: untreated

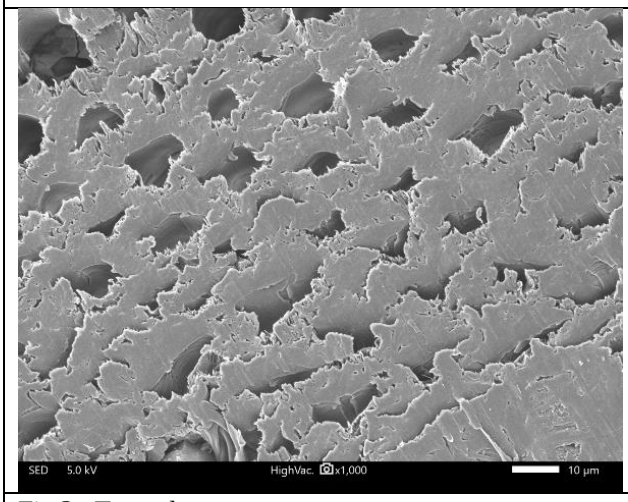
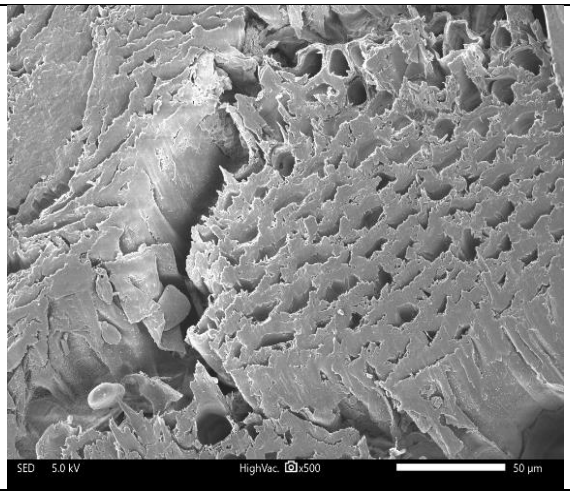


Fig 3 : Treated



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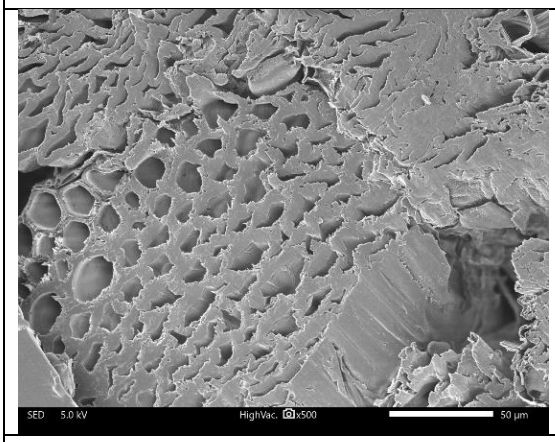

FIG 5 : Treated

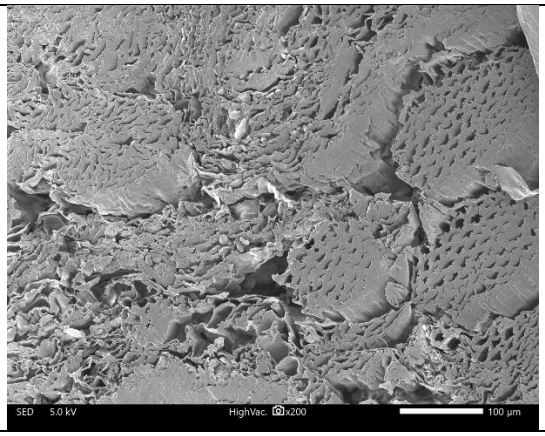

Fig 6 Treated

Physical Testing:

S.N.	PHYSICAL PROPERTY	Untreated **SAMPLE NO.** 1903083/Fibre/1	Treated **SAMPLE NO.** 1903083/Fibre/2	
1.	Bunch Length of fibre in cm	131		
2.	Denier of fiber	116	74	In-house Method
3.	Breaking strength (gf)	368.8	315.3	In-house Method

				(Gauge Length-200 mm, Speed-10 mm/min.)
4.	Tenacity, (gf/den)	3.17		
5.	Moisture content	12.2		IS: 199:1989
6.	Weight loss	-	22 %	

To soften the banana fibres, four eco-friendly enzymes: Biopectinase were applied individually to optimize the concentration and conditions and a final treatment was standardized for combinations. For all the treatment M:L ratio was 1:40. In enzyme treatment four different concentrations of Biopectinase was taken: 0.5%, 1%, 5%, 10% and 15%. It was observed that maximum weight loss was at 10 % concentration. The strength loss increased to a greater extends with the increase in concentration. Biopectinase 0.5 %, 1%, 5% and 10 % was taken. Weight loss decreased after 1 % conc. Strength loss was found higher. The performance of the treated fibres were analysed by weight loss parameter. Weight loss was due to removal of unwanted impurities. Hence it was a positive sign that the treatment was effective.

Chemical composition:
The chemical composition of untreated and treated banana fibre was carried out to analysis the change in the constituents of the treated fibres. The percent removal of hemicellulose was 68%. Lignin removal was 40%. The results of chemical composition test are given in table below:

Constituents	**Untreated banana fibre**	**Treated banana fibre**
Water soluble	10	9
Fat and wax	2	2.5
Pectins	1.7	1.1
Hemicellulose	14	5.3
Lignin	9	5.3
Cellulose	63.5	80

Yarn making and weaving process:

Yarn strength Banana fibbers are extremely strong fibres. It was essential to maintain the strength after treatment. The untreated and treated fibres were spun into yarns on phoenix charkha and hand spun technique.

For this project designed the weaving machine and made in Jalgaon according to some handloom weaving machine specification. And all the product design on this loom by hand weaving.

WEAVING BANANA FIBER ORGANICALLY | BANANA FIBER PRODUCTS | ORGANIC PRODUCTS.

HANDLOOM PRODUCT:

The work was well appreciated, as most of the people reported that this was the first time such fine variety of spun banana yarn and fabrics were seen. The woven product was found unique and was very aesthetically appealing to all the viewers. The fabric structure was also delightful. It was reported that the designers would want to develop a line using this potential fabric. Besides the fabric, there were a lot of appreciations for the concept of women empowerment through skill development of yarn spinning.

Conclusion:

Banana is harvested large scale of India and the fibre yield is around like 8.7 lakh toned. This study conveys that banana stem which is presently wasted after harvesting fruits is good cellulosic source and contains very small amount of lignin. This waste is also producing environmental pollution. The chemical formation of banana stem displays that banana stems which wasted, is a good raw material for industry. Thus, the application of waste banana stem guides us to save our forest and decrease environmental issues. From this research, it is observed that banana fibre clothing is easily made and sell into the retail market due to its high production value. Utilizing this useless material will make another option to eliminate using new material, additional other cultivated fibers and synthetic petroleum base fibers. The study represents the study and research of sustainable fibers .In this project we give vision about uses and applications of these sustainable fibers to get the competitive advantage in the market. It describes the story from history to the present use of these fibers for different applications like, DINING MAT,HANDBAGS, YOGA MAT etc and making new product like MAT.It will help the designers and companies to change their way of thinking and make new products with vision and aim of sustainability. This fibre can certainly be an eco-friendly substitute in textile industry replacing synthetic fibres which cause harm to environment. Also, it will help the rural people to earn by creating employment in the fibre extraction. The fabrics made from banana fibre will be definitely and truly an eco-friendly apparel of the future. Researchers also say that it can be cheaper than cotton and linen if produced on a mass scale. Limitations in growing fibre yielding crops and the problems in meeting the demands of the increasing population make agro-based fibres especially banana fibre the most promising and sustainable alternative to natural fibres.

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